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XXIX. *Observations on some Bivalve Insects, found in common Water, by Mr. Muller, of the new Academy of Sciences in Bavaria, and the Oeconomical Society at Bern; communicated by R. H. A. Bennet, Esq; F. R. S.*

Read April 18, 1771. **T**HE name of Bivalve is given only to those shell-fish, whose houses are composed of two parts, such as muscles and oysters. Few of these are to be met with in fresh water, whereas a vast number are inhabitants of the sea. I am acquainted with no more than four different species, like the sea bivalve; they are found in the waters of Fridricksdal, near Copenhagen, and amongst them one has hitherto escaped the researches of conchiliogists.

In return, nature has liberally stocked the same waters with small insects, much more perfect than the inhabitants of the sea-shells, and likewise provided with a double shell. It is sufficiently known, that muscles and oysters are animals extremely simple; since they want several of the most perfect organs, and consequently enjoy life in an incomplete manner. The want of eyes, arms, legs, &c. obliges them to lead an idle life, deprived of all the advantages,
which

which arise from fight and motion. Nature, from which they received an habitation sufficient to protect them from external injuries, seems to have fixed for life their abode to one dark spot. Our bivalve insects, on the contrary, by opening their two folding gates, enjoy both fight and motion, alternately dipping in the mud, and darting through their element the water ; whenever they meet with bad company, they hide themselves in their shells, and shut up the valves, which force and distress attempt in vain to force open.

I have discovered several different species of these animals in the waters of Fridericksdal, one only of which is known to the naturalists. Mr. Baker, of the Royal Society of London, is the first, that I know of, who mentions it ; “ he says*, that the “ insect swims very fast ; that it procures its nourish-
 “ ment by means of a whirlpool, which it raises in
 “ the water by means of its arms ; that, upon meet-
 “ ing with a solid body, it stops itself by means of
 “ its feet ; that upon the slightest touch it shrinks into
 “ its shell ; and lastly that it bears much resemblance
 “ to a bivalve shell-fish.” To this description he joins a figure, which, though imperfect †, represents the insect. *Linnaeus* ‡, and Geoffroi || call it the *Monocle*, and without taking notice that Mr. Baker knew it already, they observe that its *antennæ* are composed of small white threads ; and that the shell is oblong, smooth, and greyish, round on one side, flat on the

* Microscope made easy.

† Tab. XV. f. viii.

‡ *Fauna Suecica*, 1761 ; 2060.

|| Histoire des insectes, tom. ii. p. 657. 4°.

other, and nearly of the same size at each end. None of the above-mentioned writers have had the satisfaction of inspecting the inhabitant of the shell, which indeed is very difficult. Now as this insect bears a strong likeness to the new species, which I am about to describe, we shall take a view of both together.

As I was walking in the month of November 1767 along the shore, out of the Western gate of Copenhagen, I saw in a ditch of fresh water, a *conserva* *, which I carried home with me. I immediately put a lump of it to dry upon the stove; after which, upon looking at it through a glass, I discovered here and there several small white points, very smooth and shining. These I took up upon the point of a pin, and on a closer view found them to be two valved shells hardly discernible. The hinge, together with the opening and figure of them, justified my opinion. I separated the valves, and the rising part of the hinge to the edge shewed them to be shells. I regretted that the insect, a sight of which was absolutely necessary to rank them among the testaceous kind, had been destroyed by the heat of the stove. The frost came on, and prevented my making any further enquiries. I shewed my shells to three naturalists of known abilities, who agreed in assuring me that they were of the muscle kind. I had still some doubt arising from the recollection of the insect above-mentioned †, which I had found formerly: and I put off the decision, till

* Flora Fridricksdalina, 1016.

† Fauna Fridricksd. 851.

I had seen the inhabitant alive. In the beginning of April 1768, as soon as the frost broke, I got some more of the *confervas*, which I dissolved in a glass of water without discovering the bivalve; nor had I any better success upon trying the effect of the stove. During the spring, I continued my search in the country, and found several species of bivalve insects, which led me to think the inhabitant of the shell was like them. At last, in autumn, after I had given up my hopes, I found it in the Park, at the bottom of a ditch full of standing waters. The transparency of the shell gave me an opportunity of examining the inhabitant; and the examination cleared up the doubt I had about its species.

The new shell is a bivalve; white, smooth, shining, and transparent, without the least spot, hair, or down. Its figure is oblong, rounded at both ends, and the hinge somewhat sinuated at the opening, and convex at the sides, in such a manner as, when seen out of water, it is very like the seeds of some plants; and this is common to all the species of this genus. The substance is coriaceous, or like hardened glue; thin, and very brittle when dried. When seen by the microscope, some of them appear very like net work. The valves are equal, a little broader at one end than at the other, and somewhat flattened at the slope; they are not however more elevated at the opening than at the hinge, but rather the contrary; for on the inside they shew another edge, less elevated than that of the outside, and which grows less and less towards the hinge. I call by this name the place, where the valves join, though I have not been able to discover either the membrane or teeth,

which seem to shut the valves in common shells. They are however strictly joined to this place during the animal's life; which makes one think there is a ligament at the tail of the inhabitant, by which he shuts himself in. The length of the shell is half a line, and its greater breadth above a quarter of a line. That species mentioned by the above writers is three times longer before it comes to its full growth. It is hairy, though smooth to the naked eye, more indented at the slopes where the valves are projecting, and more depressed towards the hinge; it is opaque, and of a changeable colour. Some of these insects are of a light and others of a dark green, marked with an oblique stripe of a lighter than the rest. Some of these are bright, and others grey and dirty; but the down with which the shell is covered, and to which the dirt sticks, is only visible with the microscope. I have examined several of these, at different ages, and at different times of the year, and have found them all rough; whereas every one of those of the new species is smooth. I shall call this new species the *white smooth* bivalve, to distinguish it from another, the shell of which is white and rough; and from that of the above mentioned authors, which I call the *sordid*, in allusion to the dirty shell in which it is often found.

I have already observed how difficult it is to discover the shape of the inhabitants of these bivalves: however, the transparency of the *smooth white* one, gave me an opportunity of examining the lateral part of its inhabitant with the microscope; and a happy accident, by which I caught the *sordid* one at rest upon the back of its own valves, enabled

abled me to examine its fore part through a glass. I suspect that it was shedding its skin, and for this reason was quieter, and had its valves more open than usually; be that as it will, I shall now describe the remarkable animal I observed.

The head is broad towards the bottom, but decreases gradually in bulk, and terminates in a tapering point; it has on each side a small long white thread, in the form of *antennæ*. The animal seems to lower and raise the point at pleasure.

The *antennæ*, are about the length of the shell, and rest on a transparent cylindrical basis, which ends in white long capillary filaments. They appear to be stuck on at the extremity of the head, but in fact are tied to the sides, as I have often observed the animal to lower the point of its head towards its breast, without the *antennæ* following the motion. The *smooth white* bivalve has five capillary threads at each *antenna*, four of which are at top, and the fifth somewhat lower. The *sordid* appears to have ten at each *antenna*; in several, the *antennæ* appear yellowish, and their basis seems to consist of four rings.

It is by means of these *antennæ*, which are real fins, that the animal changes its position, from one place to another, being able to move them several ways; when it has a mind to move fast, they are first extended straightways, and appear like two bristles; in an instant the threads are unfolded, and the animal swims with great quickness. As for walking, it sometimes joins the threads, sometimes unfolds only a single one, and sometimes scatters them about all together; sometimes it bends them between the

valves, which are opened towards the place of the eye; it often hides one or both of them under the breast between the four legs; these *antennæ* seem to afford as great an amusement to the animal, as they do to the spectators.

At the place where the head joins the body, towards the border of the hinge of the shell, one may perceive a little black spot, which is the animal's eye. This extraordinary situation of the organ of sight upon the neck seems astonishing; every thing that is new is so, but the surprize arises only from the narrowness of our ideas. Many people would give very specious reasons for this position; others might suppose, that if the Creator had consulted us upon the matter, the eyes should have been placed in a quite contrary position, towards the extremity of the head. How childish and weak would this be! What God does, is undoubtedly most perfect; and what he orders the best possible: but what we term final causes, are seldom any more than conjectures, though sometimes they happen unexpectedly to be true. Some aquatic insects have the eye in the forehead, others at the bottom, on the fore or back part of the head, at the side or under it; nay there are some, whose head consists of the eye only. The plain reason to be given of the different positions of the principal organs, is at the same time the most probable, or at least the most within our compass. The Governor of the world is pleased to give infinite variety to his works, and only observes the laws of uniformity in the generation of each distinct species.

The breast jets out a good deal towards the opening of the shell, and constitutes the greater part of the animal's body. The feet, mouth, and little bristles are placed upon it.

There are four feet, whose position resembles a good deal that of quadrupeds, only that their reciprocal bent is more marked. The two foremost are at the top of the breast, in the part where it appears most sloped. I took them a great while for feelers, because the animal employs them to touch things with; but another use it makes of them, together with the discovery of some true bristles, makes me judge them to be legs. They are white, transparent, and jointed, bent towards the back legs, and terminated by two points in the shape of claws. The joints have very thin hair on the inferior part. The two hind legs are tied to the lower part of the breast. They are longer than the fore legs. Each joint has a couple of small threads at the end, and each leg terminates in a claw somewhat lengthened; as to the rest, they are like the fore legs, and bend towards them.

The bivalve insect makes use of its claws, not only to walk upon the *conserva*, some parts of which are true labyrinths, and others forests to him; but likewise to remove the dirt, to seize its prey, and to fasten itself to other animals of its kind, or to neighbouring bodies.

Under the breast, and near the fore feet, is a black spot, which is the insect's mouth; it is covered with a small transparent skin, which opens in the middle, and shews a couple of jaws, marked with a very black spot at the place where they join. Between these jaws hang very small white beards like those

those of the *tipula*; and above these again, there appears a small black transversal line. About the mouth there are several other little beards, somewhat in the shape of feet, which are constantly in motion.

There is no doubt but that these serve to procure a free passage to the water, and to carry the food to the animal's mouth; which employment we can by no means assign to the hinder legs, as Mr. Baker, who did not see the parts concealed between the valves of the shell, has done.

The belly is almost as broad as the breast, but has scarce above half its length. The breadth decreases towards the tail. When seen from before, the belly appears composed of two conical lobes, marked in the middle with a black circle. It moves alternately to, and retires from, the breast.

The tail comes out between these two lobes; it is of the same length with the body, and consists of two straight white and transparent canals, which are joined together till towards the end, where they separate, and each terminates in two curved points. Towards the middle of the tail, there is a little hard bristle, upon each of the canals. The animal commonly keeps this hid under his breast and belly; nor have I ever seen it extend it, unless when upon the point of wanting the necessary water, when the animal brings it out, to put himself in an easier situation; after which, it is immediately drawn in back again.

Upon the back of the insect, are likewise seen two large round bodies, which I take to be the *ovaria*.

No body, after this description, will dispute the superiority which our bivalve insect has over the bivalve shell-fish,

shell-fish, by the wonderful construction of its body, and the advantages which arise from it. But the difference of make is not the only one, since the shell too is formed in a quite different manner.

The several hypotheses of naturalists, on the formation of shells, are known; some will have them increase by *intussusception*, and others by *juxtaposition*. This latter opinion, which M. de Reaumur patronized, and which nature seemed to justify, became, in consequence, the most general; but if the friends of the other system were thought to lose their cause, it was only for want of observing with a sufficient degree of accuracy the operations of nature, whose variety would have furnished them with instances in their favour. Our bivalve insect offers one, which the desertion of the old shell and the formation of a new one, in proportion as the animal grows, put beyond a doubt. The fact itself appears, not only from the observation of empty shells of different sizes, which are to be met with in waters, and are nothing more than the spoils of our bivalve insects; but, from the singular good fortune I had, in seeing one of the animals strip itself, entirely, in my presence, of the membrane of its shell, and of the exterior parts of its body, and shew itself at last before me absolutely renewed. The *exuviae* both of the shell and the animal's body were transparent as the brightest crystal. The joints of the *antennæ*, the bristles, the feet, the smallest hairs, were more distinguishable than in the animal itself.

How infinitely small are the organs, which, hid as it were in sheaths and cases, only become visible when they are magnified some thousands of times! and how many are there which escape the best microscope!

In

In the clearest water that we drink, one can often see with the naked eye spoils of this insect, joined to those of its shell, floating along, like fine white cotton.

This adhesion proves that the body of the animal is joined to the shell by some ligaments, which possibly too may keep the valves to the hinge, as I conjectured above.

I have not yet succeeded in discovering the organs of generation ; nor have I seen the insects in the act of copulation (which cannot be less extraordinary than that of the other species of the *monoculi*) : so that I can say nothing of their sex. I have observed that they lay eggs, but this does not prevent their being likewise viviparous : I have seen other species of *monoculi*, some of which had their *ovaria* full of eggs, and others of little live beasts, which at times they hatched, and at others put down in the shell.

The *sordid* species is the most commonly met with ; one finds it all the year, even in the time of frost, from under which I have often drawn it.

It is found in all pure waters, and even in the little ditches which are exposed to be overflowed by the sea. I have preserved it from May to November, full of life and motion, in a glass of water, which I did not renew the whole time.

The *smooth white* insect lives at the bottom of marshes, and pools, in which the *conferva* I have mentioned grows.

As the entomologists have ranked the bivalve insects under the genus of the *monoculi*, I am naturally led to say something about this genus.

Systematical writers have confounded aquatic insects, very different, both in species and genus, under the general arbitrary name of *Monoculus*. They have not been contented with giving the same denomination to several species, whose properties and attributes did not at all correspond with the known characters of the genus, but have likewise given as specific marks those which nature tells us are generic. I shall only mention at present the *sordid*, which furnishes me with a striking example. M. Geoffroy, as well as Linnæus, has ranked it under the genus of the *monoculi*. According to the latter, the generic character of this, is to have two eyes and twelve feet, six of which are fixed; whereas the former gives it only one eye and six feet. Besides the difference as to the number of eyes, my description proves that the number of feet does not agree with this account. Let me add, that the particular make of the *antennæ*, the feet, the tail, and the whole body, give this insect a claim to form a genus of its own. As to the specific definition, *Antennis multiplicibus capillaceis, testa bivalvi*, and whatever else is said of it, if one excepts the colour only, belong equally to all my species with capillary *antennæ*, and constitute rather a definition of the whole genus, than of a particular species.

The same mistake is to be met with in several other species brought under this genus; and the reason of it is that the authors, not having known more than four of all the different species, which I have reckoned up in the following table, have generalized the characters of these four, though they were not well acquainted even with these.

The *water parrot*, which is the best known, both on account of its colour, sometimes red, which makes the vulgar believe that the water is changed into blood, and from the works of *Shæffer Baker*, *Geoffroy*, and *Swammerdam*, is represented by the latter as hermaphrodite, though it be different in sex, and have the parts of generation double.

The knowledge of these insects has been almost entirely neglected, though in reality very interesting; not to speak of their wonderful make, the difference of their motion, and their singular mode of copulation, are worthy of our enquiries. Let it be sufficient to say, that we swallow them and their shells, either living or dead, both in our victuals and drink; so that I should not be surprized, if some time or other they were found in our intestines, or in those of beasts, and several of our diseases attributed to them.

I propose giving the description and history of these insects, with their figures drawn to the life, as seen by the microscope: this I shall do in a work which I am projecting. To render it more compleat, I beg the favour of all naturalists to communicate their observations, which I shall not omit to give them the credit of, and at the same time, if they should find any other species, to send them to me. It is very easy to transport these insects, as they live very well in a small quantity of water for several weeks, without a necessity of a change. With these hopes I have added a list of the several species, which I have met with in the waters of *Friderikshall*. It is after having examined and compared them, at different intervals, at all ages, and in all seasons of the year, that I venture to pronounce upon their specific differences.

I shall

I shall take another opportunity of fixing the general ones.

GENS MONOCULORUM,

aquarum Friderichsdalenfium.

a Conchacei.

* Antennis capillaribus superis : capite abscondito.

1. Antennis binis : testa ovata, tomentosa. Fig. IV, V, VI.

2. Antennis binis : testa ovata fusca, ciliata.

3. Antennis binis : testa subovata, candidissima.

4. Antennis binis : testa reniformi, pellucida. Fig. I, II, III.

5. Antennis binis : testa subreniformi, fusca : fasciis tribus albis.

6. Antennis binis : testa elongata ; fascia viridi.

7. Antennis binis : testa antice truncata : strigis nigris.

8. Antennis binis : testa globosa, glaberrima.

9. Antennis binis : testa globosa, fasciis tribus nigris.

* * Antennis capillaribus inferis : capite exserto.

10. Antennis binis : cauda inflexa : testa globosa.

11. Antennis binis : cauda inflexa : testa oblonga.

N.B. Duas tantum antennis omni ratione prospicere licuit, etiam si quatuor adesse vix dubitem.

12. Antennis quaternis : cauda truncata : testa globosa.

13. Antennis quaternis: cauda inflexa lamellata: testa ventricosa.
14. Antennis quaternis: cauda erecta: testa elongata.
15. Antennis quaternis: cauda inflexa: testa antice aculeata.
16. Antennis quaternis: cauda inflexa ferrulata: testa ventricosa, mutica.
17. Antennis quaternis: cauda recta: testa univalvi.
N.B. Hi potius binoculi & ultimus quidem proprii generis.

* * * Antennis ramosis: capite manifesto.

18. Antennis dichotomis: cauda inflexa: testa sub-rhombea mutica.
Pulex non caudatus Schæff. monog. t. 1. f. 9.
19. Antennis dichotomis: cauda inflexa: testa gibba quadrangulari.
20. Antennis dichotomis: cauda inflexa verrucosa: testa postice aculeata.
Pulex caudatus Schæff. monog. t. 1. f. 1—8.
21. Antennis dichotomis: cauda inflexa: testa antice ferrulata, postice aculeo longo.
22. Antennis dichotomis: cauda inflexa: testa antice ciliata: corniculis porrectis longis.
23. Antennis dichotomis: cauda inflexa: testa antice pilosa: corniculis pendulis.
24. Antennis dichotomis: cauda inflexa appendiculata: testa postice acuta.
25. Antennis dichotomis: cauda inflexa appendiculata: testa antice aculeata.
26. Antennis dichotomis: cauda deflexa: testa mutica: corniculis porrectis brevibus.

Fig. I.



Fig. II.



Fig. III.



Fig. IV.



Fig. V.



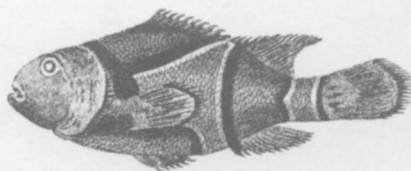
Fig. VI.



Fig. VII.



Fig. VIII.



27. Antennis dichotomis : cauda recta : testa ovata mutica.
 28. Antennis trichotomis : cauda recta : testa angulis anticis fetiferis.

b Cataphracti.

* Antennis binis.

29. Antennis binis simplicibus : cauda recta bifurca.
 30. Antennis binis simplicibus : cauda curva bifurca, laciniis pendulis.
 31. Antennis binis simplicibus : cauda bifeta.
 32. Antennis binis simplicibus rigidis : cauda bifida.
 33. Antennis binis dichotomis : cauda inflexa.

* * Antennis quaternis.

34. Antennis quaternis simplicibus : cauda recta bifida.

Baker microscop. t. 15. f. 1—4.

Hafniæ, 24 Nov. 1768.

Otto Fridericus Müller.

Acad. Cæs. N.C. Scientiarum Boicæ,
 ac Societ. Oecon. Bernens.

Explanation of the Bivalve Insect, TAB. VII.

Fig. I. The smooth white insect as it is naturally.

Fig. II. The same, seen through the magnifier.

Fig. III. The same magnified by the microscope.

The transparent shell shews the inhabitant lying at its full length ; with the *antennæ*, legs and tail, out of the valves.

a The edges of the two valves.

b The *antennæ*.

c The eye.

d The

- d* The head.
- e* The *ovaria*.
- f* The fore legs.
- g* The hind legs.
- b* The tail.
- i* The fore part of the breast, where the beards
and mouth are placed.
- k* The belly.

Fig. IV. The *fordid* shell of its natural size.

Fig. V. The same, as seen through the glass.

Fig. VI. The same, with the shell a little opened, and
more magnified.

- a* The rough shell.
- b* The oblique stripe.
- c* The *antennæ*.
- d* The fore legs.
- e* The hind legs.
- f* The mouth and joints.
- g* The tail.

Fig. VII. The same, with the shell shut.